Status of IMERG, the U.S. Multi-Satellite Algorithm

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1. INTRODUCTION

A diverse, changing, uncoordinated set of input precip estimates

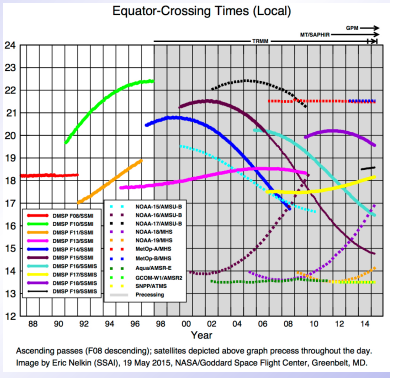
Goal: seek the longest, most detailed record of "global" precip

Integrated Multi-satellitE Retrievals for GPM (IMERG) is a High-Resolution Precipitation Product

- best snapshot precipitation
- not a Climate Data Record

IMERG is a unified U.S. algorithm that takes advantage of

- KF-CMORPH – NOAA
- PERSIAN-CCS – U.C. Irvine
- TMPA – NASA
- PPS production – NASA



Ascending passes (F08 descending); satellites depicted above graph precess throughout the day.
Image by Eric Nelkin (SSAI), 19 May 2015, NASA/Goddard Space Flight Center, Greenbelt, MD.

2. IMERG Data Sets

Multiple runs accommodate different user requirements for latency and accuracy

- "Early" – 6(4) hours (flash flooding)
- "Late" – 16(12) hours (crop forecasting)
- "Final" – 3 months (research data)

Time intervals are half-hourly and monthly (Final only)

0.1° global CED grid

- PPS will provide subsetting by parameter and location
- initial release covers 60°N-S

User-oriented services

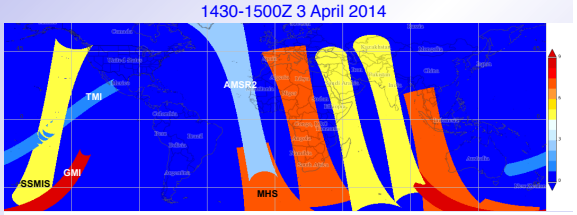
- interactive analysis (GIOVANNNI)
- alternate formats (KMZ, KML, TIFF WRF files, OpenDAP, …)
- area averages

	Half-hourly data file (Early, Late, Final)
1	*[multi-sat.] precipitationCal*
2	[multi-sat.] precipitationUncal
3	*[multi-sat. precip] randomError*
4	[PMW] HQprecipitation
5	[PMW] HQprecipSource [identifier]
6	[PMW] HQobservationTime
7	IRprecipitation
8	IRkalmanFilterWeight
9	*probabilityLiquidPrecipitation [phase]*
	Monthly data file (Final)
1	*[sat.-gauge] precipitation*
2	*[sat.-gauge precip] randomError*
3	GaugeRelativeWeighting
4	*probabilityLiquidPrecipitation [phase]*

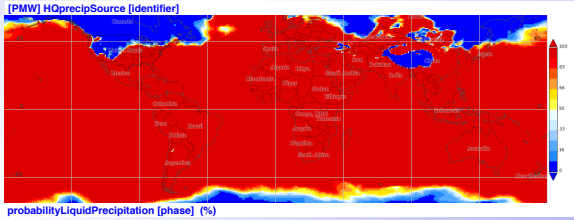
3. EXAMPLES – Data Fields from IMERG Test Data

1430-1500Z 3 April 2014

PMW sensor contributing the data, selected as imager, then sounder, then closest to center time

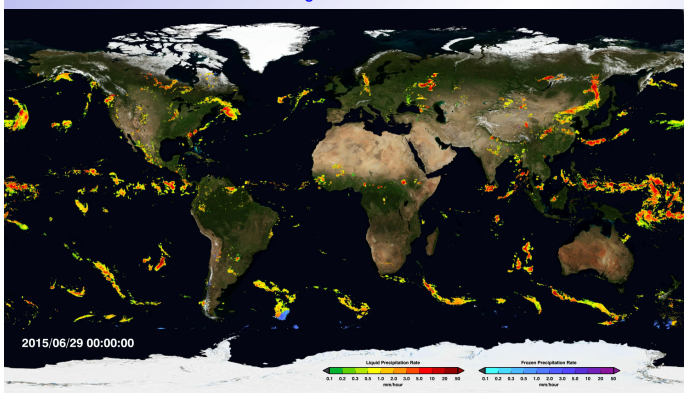


probability that precipitation phase is liquid; diagnostic computed from ancillary data



3. EXAMPLES – Recent Week of Early IMERG

Ending 150706 1630Z



[Courtesy Sci. Vis. Studio; http://svs.gsfc.nasa.gov/cgi-bin/details.cgi?aid=4285]

4. VALIDATION – Release Notes

"Day 1 IMERG Final Run Release Notes"

- an introduction and first cut at comparisons
- a living document
- *http://pmm.nasa.gov/sites/default/files/document_files/IMERG_FinalRun_Day1_release_notes.pdf*
  - this and all documents hot-linked on the IMERG data access page, accessible on the Level 3 tab on *http://pmm.nasa.gov/data-access/downloads/gpm*
- specific features, problems, behaviors
- effects due to IMERG's structure
- cautions due to the input data
- biggest overall issue is that none of the inputs or IMERG are fully GPM-based

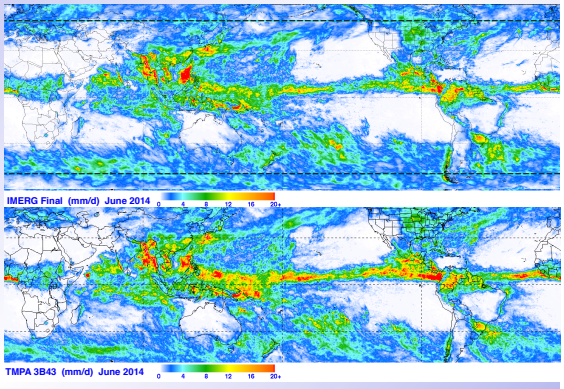
4. VALIDATION – IMERG Final Run vs. 3B43 for June 2014

Same input satellites, different algorithms, different calibrator

- 2BCMB vs. 2B31

Similar features, but not identical

- features (SPCZ)
- bias (ITCZ)



4. VALIDATION – 3-Hourly, 0.25° IMERG, 3B42, MRMS for 15 June 2014

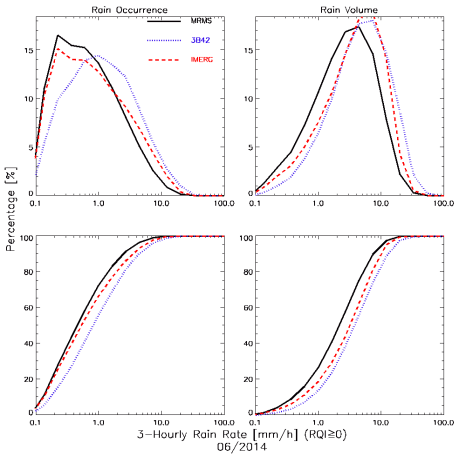
IMERG better than 3B42 for precip occurrence

IMERG performs modestly better for precip volume

Note: Original footprint GPROF retrievals below 0.1 mm/hr are thresholded to zero

- how this affects IMERG depends on the resolution of the input sensor and subsequent averaging (here 0.25°)

[Courtesy J. Wang (SSAI; NASA/GSFC 612)]

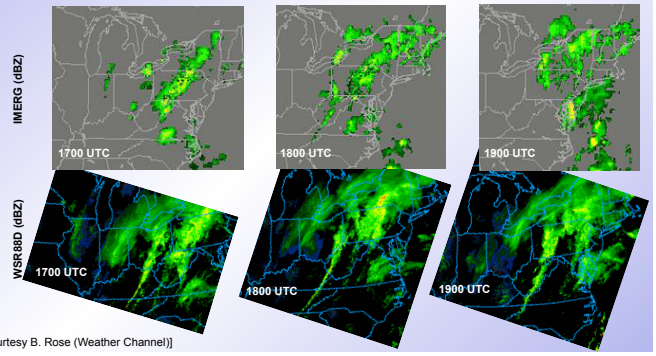


4. VALIDATION – Snow in IMERG, NWS WSR88D, 12 March 2014

IMERG converted to dBZ, WSR88D in dBZ; both original resolution

Hang-back line in radar missing in IMERG

2-5" of snow with near-blizzard conditions at Cleveland, Ohio around 1900 UTC



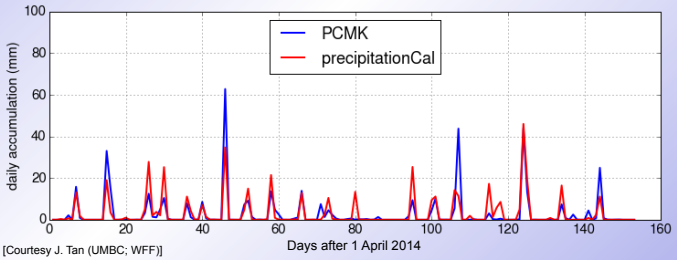
[Courtesy B. Rose (Weather Channel)]

4. VALIDATION – Daily IMERG and Pocamoke Fine-Scale Grid, April-August 2014

20 surface gauges in a 6x5 km region near Wallops Island, Virginia

Excellent correlation for event occurrence (warm season)

Both over- and under-estimates for largest events



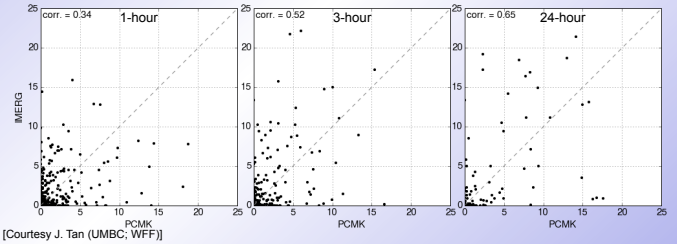
[Courtesy J. Tan (UMBC; WFF)]

4. VALIDATION – Accumulations of IMERG and Pocamoke Fine-Scale Grid, April-August 2014

"Triangular distribution" is typical of fine-scale estimates

Time-averaging pulls points towards the 1:1 line

Improvement is slow and depends on events and selection of sensors



[Courtesy J. Tan (UMBC; WFF)]

4. VALIDATION – Half-Hourly IMERG Sources and Pocamoke Fine-Scale Grid, April-August 2014

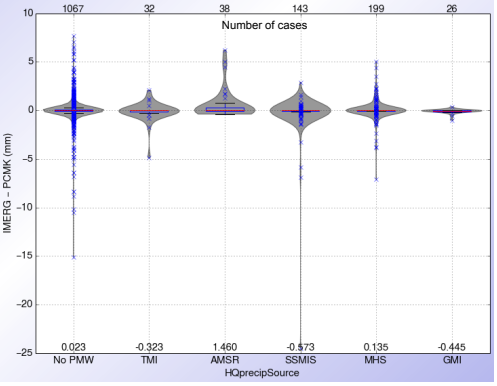
"Violin diagram" for individual sources of the half-hourly IMERG estimates

- width shows relative contribution for each difference bin

GMI is best; AMSR and SSMIS less so

The extra scatter for no-PMW (interpolated) is partly driven by the large number of cases

No-PMW (interpolated) data are competitive with the skill for most of the sensors



[Courtesy J. Tan (UMBC; WFF)]

5. FUTURE – Transitioning from TRMM to GPM

IMERG is available
- Final Run for mid-March 2014 to February 2015
- Late Run from 7 March 2015
- Early Run from 1 April 2015

Early 2016: first-generation GPM-based IMERG archive, March 2014–present

Early 2017: first-generation TRMM/GPM-based IMERG archive, 1998–present

What happens to TMPA now that the TRMM satellite has de-orbited?
- PR products stopped 8 October 2014
- TMI was shut down 8 April 2015
- TMPA-RT uses climatological calibration, so continues to run "as is"
- production TMPA partly depends on PR for calibration
  - production switches to climatological calibration with October 2014
  - gauge calibration over land should continue to yield consistent results
  - climatological calibration over ocean is likely to cause a discontinuity
- plan to continue TMPA into Spring 2017 to support users
  - loss of server or legacy sounder estimates could raise issues

5. FUTURE – The Big Challenges

Extending the analysis to the poles

Estimating the fine-scale errors
- then the grand challenge is aggregating the errors in space/time

Orographic enhancement

Precipitation system growth and decay

Accounting for differences in what different sensors "see"

6. FINAL COMMENTS

The U.S. Day-1 GPM multi-satellite precipitation algorithm is constructed as a unified U.S. algorithm

IMERG is becoming available
- Final Run for mid-March to December 2014
- Late Run starts 7 March 2015
- Early Run in Beta Test from 1April 2015
- GPM era reprocessed in early 2016
- TRMM-GPM eras reprocessed in early 2017
- TMPA to be run until mid-2017

Even the Day-1 datasets are typically an improvement over TMPA
- There is no substitute for seeing how particular IMERG runs work for your application

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pmm.nasa.gov

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GLOBAL PRECIPITATION MEASUREMENT
New Users Start Here

Reserve Slides

2. IMERG DESIGN – Processing

IMERG is a unified U.S. algorithm that takes advantage of
- Kalman Filter CMORPH (lagrangian time interpolation) – NOAA
- PERSIANN with Cloud Classification System (IR) – U.C. Irvine
- TMPA (inter-satellite calibration, gauge combination) – NASA
- all three have received PMM support
- PPS (input data assembly, processing environment) – NASA

The Japanese counterpart is GSMaP

Institutions are shown for module origins, but
- package will be an integrated system
- goal is single code system appropriate for near-real and post-real time
- "the devil is in the details"